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The Case for the Loch Ness "Monster": The Scientific Evidence

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Abstract—Loch Ness Monsters (Nessies) are—if they exist—animals of a species either not yet known to science or known but thought to have been long extinct. Much controversy has concerned eyewitness testimonies and photographs whose relevance and validity are uncertain. However, there also exists a body of objective evidence that critics have been unable to gainsay: the Dinsdale film; numerous sonar echoes obtained over many years by different investigators; and underwater photography in 1972 coincident with sonar detection of large targets.

It is suggested that the natural habitat of Nessies is at significant depths, in sea fjords as well as in "monster" lochs.

Keywords: Loch Ness Monster—Nessies—eyewitness testimony

Introduction

Claims of a Loch Ness Monster, a.k.a. Nessie, have arisen because people persistently (albeit infrequently) see, at Loch Ness:

1. some things whose identity remains to be established; or
2. animals whose identity remains to be established; or
3. animals belonging to a known species—sea lions, say, or sturgeon—whose identity is not recognized by the observers; or
4. animals belonging either to a presently unknown species or to a species thought long extinct, in particular some species looking like or related to plesiosaurs.

The first claim is not controversial. Many accept the second. One or more of the first three are accepted by most "disbelievers", namely those who reject the fourth possibility. The fourth defines Nessie "believers" (and thereby also Nessies) for the purpose of this discussion. Thus, evidence required to establish the existence of Nessies is evidence for claim 4 as against claim 3.

There is general agreement that some of the purported evidence stems from fakes, hoaxes, and misperceptions on the part of eyewitnesses. Is there any other evidence? More particularly, is there any *scientific* evidence? For, in-

evitably, the arbiter of this evidence must be science, in this case marine biology and perhaps also palaeontology.

Eyewitness Testimony

Among believers, a common aphorism holds that the testimony of eyewitnesses to the existence of Nessies is so strong that its equal, in the case of a trial for murder in a court of law, would unquestionably lead to a conviction and subsequent hanging. (The aphorism has not been re-worded since abolition of the death penalty.)

However, in a murder trial the witnesses are testifying to observation of *recognized, identified* things. Claims 3 and 4 concern *unidentified, unrecognized* things; eyewitness testimony alone cannot authoritatively establish either one of them, nor distinguish between them. Therefore the case for Nessies must be made on a different basis, namely whatever objective evidence can be adduced.

There is also a quite general, pragmatic reason why science can make only the most limited use of eyewitness reports. The purpose of science is to expand knowledge. Therefore, to be useful a report (or a method, or a theory) must indicate how investigation can be taken further. Even seven decades of eyewitness reports of Nessies, however, offer no guidance as to how further information about the creatures might be obtained. Indeed, the sightings have been so irregular and unpredictable that the cumulative record constitutes an argument against attempting a program of intensive scientific surveillance for appearances of Nessies at the surface; as Adrian Shine once remarked, that would be a war of attrition against the laws of chance.

Accumulation of Evidence

For the reasons just given, "evidence" in the following will imply *objective* evidence of film and sonar, records of which can be permanent and available for re-analysis in the light of fresh data or new ideas.

The Loch Ness Monster first garnered wide attention in the public media in the 1930s (Bauer, 1982, 1987a, 1988). For several years during that decade, photographic evidence as well as eyewitness testimony made news, and a book was written about the Monster (Gould, 1934). Neither then nor since, however, has mainstream scientific activity attended to the matter (Bauer, 1986).

From the mid-1930s until 1960, sightings continued, but little fresh scientific evidence was uncovered. However, between 1960 and 1975 a significant amount of new data was gained from organized group activities as well as individual initiatives. That flurry of activity had been set off by a magisterial book (Whyte, 1957), reinforced by Dinsdale's filming of a Nessie (Dinsdale, 1961) and culminating in successful underwater photography (Rines et al., 1976) by the Academy of Applied Science (AAS). Nessies were assigned the taxonomic identity *Nessiteras rhombopteryx* (Anonymous, 1975).

Fig. 1. The Surgeon's photo, which has become iconic for Nessies. It was first published in the *Daily Mail* on 21 April 1934.

It seemed reasonable to expect that further deployment of the methods that had achieved these successes would soon deliver scientifically definitive proof of the existence of Nessies and insight into their nature. Instead, the last quarter century has produced little evidence beyond further sonar echoes, notably those obtained by the Loch Ness & Morar Project in 1980 (LN&MP, 1983) and during Operation Deepscan in 1987 (Bauer, 1987b; Dash, 1988).

A pessimistic explanation for the dearth of recent results is that the creatures may have become extinct, perhaps as a result of increasing pollution (Rines, 2001). An alternative explanation is that much of the earlier success was fortuitous and that the best search techniques remain to be identified. This essay seeks to make that argument. In addition, it will consider recent efforts to discredit earlier data, namely allegations that

1) the hump filmed by Dinsdale was a boat;
2) underwater photographs were retouched or of inanimate objects;
3) the iconic Surgeon's photo (Figure 1) was a hoax.

The Strongest Evidence

The strongest objective evidence for Nessies comprises the Dinsdale film, numerous sonar results, and underwater photographs obtained at the same time as strong sonar echoes.

The Dinsdale Film

In 1960 Tim Dinsdale filmed a Nessie moving at or near the surface of the water, using a 16-mm Bolex and telephoto lens at a range of about a mile (Dinsdale, 1961). The film was shown on British television and featured in innumerable lectures given by Dinsdale over the years. Bits of the film appear in

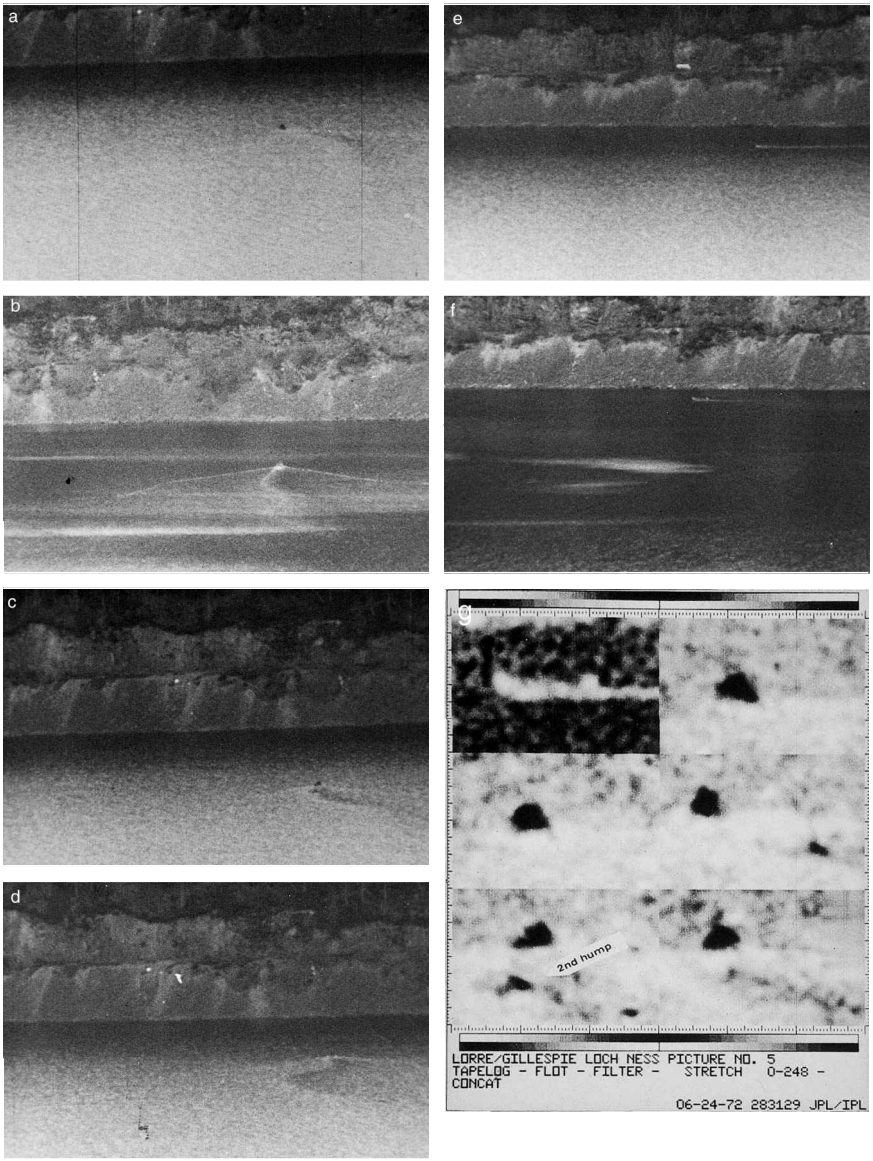

Fig. 2. Reproduced by kind permission of Wendy Dinsdale. The originals are in Dinsdale (1961), but Figure 2g is only in the 3rd and 4th editions. a) a triangular dark hump is moving away, leaving a broad wake. b) A boat (shown at the same distance) leaves a clear propeller wash as well as a bow wake. c) The hump swerves to the right and a smaller second hump is visible behind the first, on the right-hand side of the wake. d) The wake narrows abruptly and the hump is no longer visible (the arrow above points to a sea gull). e) The wake is moving right to left, parallel to the far shore, with nothing else visible above the waterline. f) The boat at the same distance shows its outline and the helmsman at the back. g) Several frames computer-enhanced: the control boat upper left and several views of the hump, including two that show the smaller second hump.

a number of videos and TV documentaries (Bauer, in press). Most of it is included in the video shown regularly (beginning in 2001) at the Original Loch Ness Monster Exhibition at the Loch Ness Lodge Hotel in Drumnadrochit, Scotland. Stills from it (Figure 2) are reproduced in all editions of Dinsdale's book, *Loch Ness Monster,* as well as in Bauer (1986).

Figure 2a shows the dark hump of the supposed Nessie at the beginning of the Dinsdale film. The Joint Air Reconnaissance Intelligence Centre (JARIC) in Britain later concluded that the hump projected about 3 feet out of the water and was 5½ feet wide at the water-line (James, n.d.)[1].

The wide, heavy wake produced is sensibly different from that left by a boat (Figure 2b): the boat leaves not only a broad bow-wave but also a distinct trail from the propeller. The hump produced only bow-wake.

In Figure 2c, the hump swings to the right and a smaller hump appears briefly behind it and toward the right side of the wake; see also the computer enhancement in Figure 2g.

In Figure 2d, the wake narrows abruptly and the hump disappears but the wake continues: something large is evidently now moving just below the surface. JARIC commented (James, n.d.) that, unless there had been a submarine in the loch, the hump was probably an animate creature moving at up to 10 mph. There was no submarine in the loch at that time (nor has there ever been, to the present time, a submarine in Loch Ness capable of such speeds; several mini-subs have been deployed at various times, but they are considerably slower).

Having swung to the right, the wake then curved left and proceeded roughly parallel to the shore, from right to left in the film (Figure 2e). Only the wake is visible above the water-line, whereas a boat at the same distance is clearly recognizable (Figure 2f).

This last sequence of the film also shows "a definite paddling action, swirling the water back in the manner of a breast stroke swimmer" (Dinsdale, 1961: 115). I have a copy of the film, given to me by Dinsdale in 1975, including this right-to-left sequence that had been magnified 2x and 4x for the BBC-TV program, *Panorama.* I have had the film transferred to video and have watched it innumerable times. The wake in this right-to-left sequence is made by something projecting a foot or two above the water but hidden by the trail of white foam it throws up. Periodic splashes originate *at the side* of the wake, indicating that they are paddle strokes and not any effect of the wake cutting across prevailing waves on the loch—the latter would produce splashes at the head of the wake and not at its side. These splashes are rather clearly visible in several television programs or videos: in *In Search Of...* (1976) (albeit the film is reversed, the hump moves from left to right instead of from right to left!); in *Secrets & Mysteries* (ABC video, 1987), *The Loch Ness Monster Story* (North Scene, 1991), and *Great Mysteries of the 20th Century* (TLC, 1996); there is only one such splash, but a very clear one, in *The Beast of Loch Ness* (NOVA, 1998). It is also noteworthy that the front of the wake shows no

vertical movement. The bow of a boat riding along the surface would show some rocking movement up and down if it encountered waves; in contrast, the steadiness of the front of this wake marks it as being caused by something projecting from a massive submerged object. A similarly steady progression is shown by the wake recorded in the summer of 2001 and broadcast on network television in December (CBS, 2001).

Figure 2b and f are available because Dinsdale, having filmed the hump, persuaded the host at his hotel to steer a motorboat over the same path as the hump had taken[2]. The camera was then sealed and the film developed at the Kodak laboratories (Dinsdale, 1961: 105 ff.). Since then, it has been computer-enhanced several times by different people[3], without defining the hump's shape better than approximately triangular in cross-section; but the brief appearance of the second, smaller hump showed up more clearly in an enhancement (Figure 2g).

The Dinsdale film demonstrates that, in April 1960[4], there was in Loch Ness a large, fast-moving creature unlike any species known by science to inhabit the loch. The boat filmed by Dinsdale as a control and the several computer enhancements, as well as examination of the original film by Kodak experts and by JARIC, all seem to disprove conclusively any notion that the hump could actually have been a boat. Yet that is the only suggestion that Nessie-disbelievers have made in their attempts to explain away the Dinsdale film (Binns, 1983; Burton, 1961; S. Campbell, 1986a; see below, *The burden of proof*).

Sonar

Sonar detects objects in the water by the echoes of sound waves reflected from them. Since the speed of sound in water is known, sonar enables accurate calculation of how far away the reflecting object is. The strength of the echoes depends not only on the size of the target but also on what it is made of: a small bubble of air may give as strong a signal as a large piece of water-logged wood. For that reason, and also for reasons of inherent lack of definition, sonar does not give useful information about shape or size, especially not with fast-moving targets[5].

Sonar echoes stronger than from fish and often from moving objects have been obtained in Loch Ness on many occasions since the 1950s. In 1968 engineers from Birmingham University testing a new digital sonar detected large objects rising apparently from the bottom, coming swiftly up hundreds of feet and then returning to the bottom (Braithwaite, 1968). In 1969 a big object moved parallel to the sonar-equipped boat at several miles per hour, then turned back and moved away (LNI, 1969). During the summer of 1980, several dozen large echoes were obtained over deep water by the Loch Ness & Morar Project (LN&MP, 1983). During Operation DeepScan in 1987, three substantial contacts were fleetingly made in deep water (Bauer, 1987b; Dash, 1988).

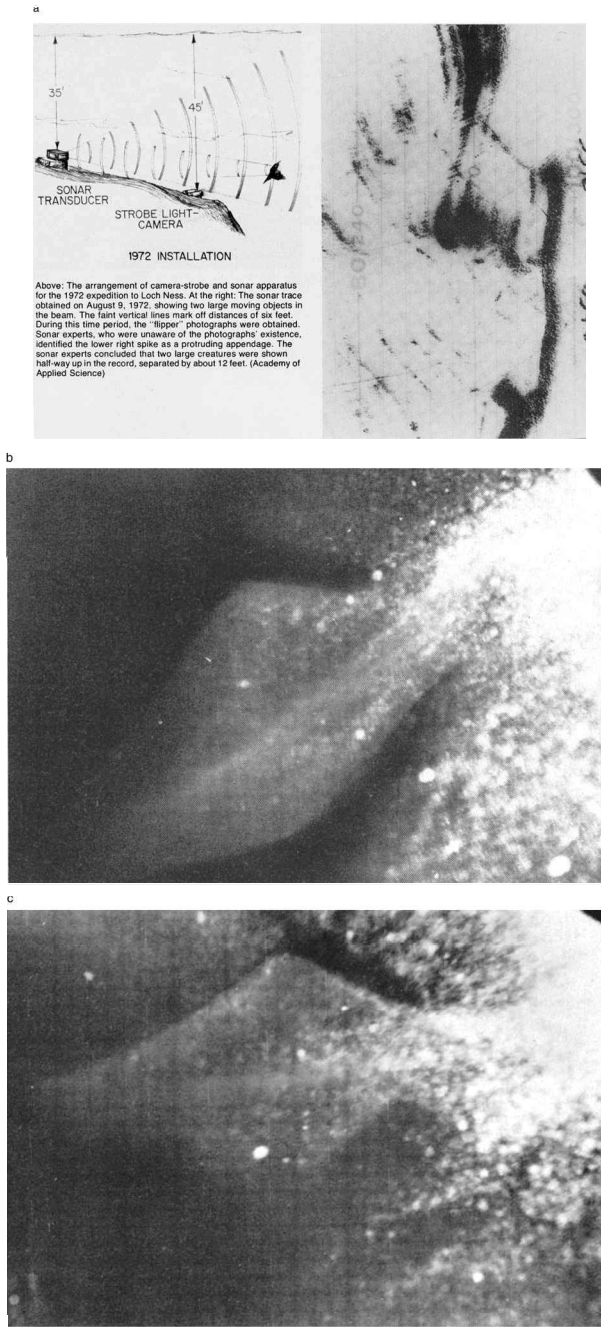
a
35'
45'
SONAR TRANSDUCER
STROBE LIGHT-CAMERA
1972 INSTALLATION
Above: The arrangement of camera-strobe and sonar apparatus for the 1972 expedition to Loch Ness. At the right: The sonar trace obtained on August 9, 1972, showing two large moving objects in the beam. The faint vertical lines mark off distances of six feet. During this time period, the "flipper" photographs were obtained. Sonar experts, who were unaware of the photographs' existence, identified the lower right spike as a protruding appendage. The sonar experts concluded that two large creatures were shown half-way up in the record, separated by about 12 feet. (Academy of Applied Science)
b
c

Fig. 3. Reproduced by permission from Rines et al. (1976). a) Sonar chart shows thin black traces of echoes from moving fish and massive reflections from one or two larger objects. b, c) Simultaneous with the sonar echoes, two film frames showed a paddle or flipper.

The best listing of all sonar results and attempts at Loch Ness, up to the early 1970s, is in Roy Mackal's *The Monsters of Loch Ness* (in fact that book comprises the best survey of all data—films, photos, sightings—up to that time). Between 1954 and 1972, Mackal lists sixteen occasions when sonar watches were active, on one of them using two different search modes (Mackal, 1976: Appendix E, Table 3, pp. 296–97). Of these seventeen sets of observations, nine gave positive results, three were inconclusive, and five yielded no contacts. This success rate of at least 50%, supplemented by the 1980 and 1987 results, approaches scientifically respectable reproducibility.

The most auspicious results came in 1972 when sonar detected large objects that were captured at the same time by underwater photography.

Sonar with Simultaneous Photography

In August 1972, the AAS obtained strong echoes from what appeared to be two discrete objects (Rines et al., 1976).

In Figure 3a, the relatively thin, oblique traces on the sonar chart are typical of fish, say salmon of a foot or two in length, but there are also thick traces from much larger objects, consistent with fish fleeing from predators. At the same time, an underwater camera equipped with a strobe light was exposing film about every 45 seconds in the same direction as the sonar beam pointed. Three frames of the developed film showed faint outlines of something in the water; computer enhancement revealed more clearly on two of them the outlines of a flipper or fin or paddle (Figure 3b, c). The axis of the flipper changes just as one might expect of a moving limb; or perhaps one was a front limb and the other a hind limb. Since the sonar gave an accurate measure of how distant the objects were, it was possible to convert the dimensions in the photo into the actual size of the object shown: the length of the flipper(s) was about 6 to 8 feet and the width about 4 feet. Monster indeed!

Retouched?

Some critics have alleged that these photos were retouched (Anonymous, 1984), which would mean having something added or subtracted that was not in the originals. Again in a television program (TLC, 2001), Adrian Shine was shown as supposedly revealing "for the first time" a flipper print with the distal edges indicated as not having been visible in the original, according to a signed statement by Charles Wyckoff, dated 7/7/89. Actually, this allegation—that Wyckoff believed some retouching had been done by persons unknown—had already been made a decade earlier in the commercial video, *The Loch Ness Monster Story* (North Scene, 1991), albeit without the signed statement being shown. Why had the producers of that video not asked for Wyckoff's first-hand statement about it? Wyckoff died in 1998, before the TLC program was made, but he had been available in 1991. Why wait until now to make this 1989 document public for the first time?

I suggest that the reason for the delay is that Wyckoff might have pointed out that his signed statement of 1989 is not inconsistent with a letter he wrote in 1984 denying allegations of re-touching: "When the original 1972 film was developed by Kodak under bond, the transparencies in original form and without any enhancement, were examined by me and various authorities, including those at the Smithsonian, and were responsible for the published descriptions of the appendage shown therein"; "the Academy of Applied Science has never produced or released a single 'JPL [Jet Propulsion Laboratory] computer enhanced photograph' with the slightest bit of 'retouching' or change"; the flipper photos published by the Academy (Rines et al., 1976) were composites superimposing several computer enhancements in order to optimize edge sharpness as well as contrast, "a recognized and proper procedure" (Wyckoff, 1984).

The originals of the flipper photographs are *transparencies*; therefore *any* reproduction of them in print involves some choice of enhancement in the endeavor to make clear what the transparency shows[6]. When film is developed and printed, some "enhancement" is inevitable: choices of developer and of development time influence the resulting degree of contrast. To query computer enhancement is no more soundly based than to query the printing of a negative, it is just that computer software offers a greater subtlety of relevant choices for *clarification.*

The computer enhancing of the flipper photos was carried out at the Jet Propulsion Laboratory in Pasadena, California (where early photographs of the moon had also been computer-enhanced) by Alan Gillespie, who wrote (1980): "Something unusual was in the image, and it was not an artifact of processing, and it had flippers of some sort". "Computer-enhanced" means *enhanced,* not altered. Photos or negatives are scanned—the light intensity measured at every point—and then computer software examines the stored data. It may look for edges, change the contrast, remove "speckle", compensate for the gradient of light created by the photographic strobe-light, or apply various color filters.

The television program, *The Beast of Loch Ness* (NOVA, 1998), reproduces (1) the original transparencies which show the medial "spine" and adjoining portions of the flippers; (2) a computer enhancement in which these portions of the flipper are seen to form a connected surface with clear proximal edges but only indistinct distal ones; and (3) a supposedly retouched version similar to commonly published ones, in which the distal edges of the flipper are sharper and more distinct. The indubitably *not* retouched versions (1) and (2), which Wyckoff's letter supports as genuine, are sufficient to make the case that it is a flipper. Moreover nothing in (3) is inconsistent with (1) or (2). It is therefore irrelevant to the main question of the existence of a large creature, whether the distal edges are straight or webbed or ragged: the significant fact is that at least one and possibly two large flippers were photographed with simultaneous sonar confirmation of the presence of one or two large moving objects.

Collateral Evidence

Surely the Dinsdale film, the variety of sonar results, and the flipper photos with concomitant sonar establish the existence of Nessies beyond any reasonable doubt: these are not seals, sturgeon, eels, water birds, otters or any of the other known species that have been suggested over the years as responsible for sightings at Loch Ness. The various disbelievers' attempts to explain this evidence under claims 1 to 3 (above) have been unsuccessful.

Much other evidence has been displayed in books and in public media. In another article (Bauer, in press) I discuss the television and video coverage of Nessies that has largely ignored the strongest evidence while featuring controversies over the more doubtful material. There remain some significant but often ignored points to be made about the less conclusive evidence.

Eyewitnesses

Many descriptions by eyewitnesses can be read in several books: the earliest in Gould's *The Loch Ness Monster and Others* (Gould, 1934); a convincing collection from local residents, people personally known to Constance Whyte, in *More Than a Legend* (Whyte, 1957); and some fascinating anecdotes in Tim Dinsdale's classic *Loch Ness Monster* (Dinsdale, 1961). Nicholas Witchell's *The Loch Ness Story* (1974) is the most recent[7] as well as comprehensive book that recounts the story of searching for Nessies. By themselves, eyewitness reports may mean next to nothing in science. Still, it is difficult to discount such reports as those of police officers Cameron and Fraser on one side of the loch, whose sighting was corroborated by quite independent eyewitnesses on the opposite shore (Holiday, 1970: 115–122).

The most common description is of a hump, often said to look like an upturned boat. Sometimes much splashing or roiling of the water is reported, sometimes not. A long protrusion, usually described as a neck, sometimes as a tail, is seen less often than humps or wakes. Even when necks are reported, rarely is a clearly defined head noted (although a few people have described protrusions that could be horns or antennae or ears). The color is almost always called dark gray or brown or black. The texture of the surface is never described as fish-like—in other words, with scales—but rather as rough or knobby or warty, reminiscent of an elephant's hide. Quite often, the creatures are described as submerging by sinking vertically.

Other Locales

Disbelievers point to the implausibility that a single creature—a Jurassic plesiosaur, no less—should have survived in this one spot. However, Nessie fans envisage not that unlikely scenario but rather a breeding population of creatures that became landlocked after the last Ice Age (Whyte, 1957). This is consonant with reports of similar creatures from a number of other lakes in the

northern temperate zone (e.g., Dinsdale, 1961: chapter 9), as well as hundreds of sightings from the oceans (Heuvelmans, 1968).

The Burden of Proof

A common aphorism about anomalous phenomena is that extraordinary claims demand extraordinary proof. One needs to be clear, therefore, about what is being claimed. The assertion that Nessies exist (claim 4 above) does not specify that they are necessarily plesiosaurs, zeuglodons, giant invertebrates, giant amphibians, or any of the other suggestions made over the decades; it is simply the claim of an *unspecified* type of creature not currently known by science to be extant. I suggest that the objective evidence detailed above is sufficient to sustain this claim and that "skeptical" counter-arguments should address *this* claim and the objective evidence for it.

Disbelievers have offered any number of arguments that are, in this light, irrelevant. No one denies that hoaxes have been perpetrated or that misperceptions have been widespread. I accept that there are good reasons why one would not expect to find plesiosaurs, zeuglodons, or the like in Loch Ness. The case for Nessies is not that they are a particular kind of Jurassic reptile or even that their existence is likely; it is just that the objective evidence of film and sonar shows them to be there.

In considering this objective evidence, then, the burden of proof comes to rest on the disbelievers. In the following, I argue that their responses have been inadequate, an instance of "pathological skepticism", to use Edmund Storms' nice phrase (Chubb, 2000).

The Dinsdale Film

The only explanation offered by disbelievers is that Dinsdale filmed a boat. I have already pointed out that the hump shows no propeller wash. It also remains to be explained how a boat could display the additional feature of a second hump; the pronounced narrowing of the wake as the hump disappears, midway in the loch, while continuing to produce a wake; or the oar-like splashes to the side of the wake.

Maurice Burton (1961: 73) wrote that the hump took "precisely the route frequently taken by the local boats in crossing over from Foyers"; but he fails to specify where those boats might be heading. Opposite Foyers the ground slopes steeply (and even the stills from the Dinsdale film, Figure 2, show this rather clearly). The nearest jetties are several miles north in Urquhart Bay, several miles south at Invermoriston, or even further south at Fort Augustus. Why would boats heading south "frequently" go first half way into the loch and then turn north before swinging south?

Many years later, Burton (1969) offered further detail: "a local farmer, Jock Forbes, was, to quote a local resident, 'in the habit of going across with cargo about nine on a Saturday'". What sort of cargo? Who is the cited "local resi-

dent"? Why had Burton not obtained confirmation from Forbes himself? Why had this not been reported in Burton's book?

Much later again, Burton (1982) said that the narrowing of the hump's wake in the Dinsdale film occurred "at the spot where the boats I watched crossing over, in 1960, shut off their motor, turned hard towards the beach and disappeared suddenly under the over-hanging branches of trees". But there is no beach opposite that spot (and why would the boats then run south, parallel to the shore?), nor are there overhanging branches on trees near the middle of the loch, which is about a mile wide.

Were a Nessie believer to make and revise *ad hoc* such undocumented claims as Burton's, moreover contradicting easily verifiable geographical facts, the skeptics would rightly rule the claims as unworthy of consideration. Yet S. Campbell (1986a: 60, 1986b) relies on Burton's implausible claims about local dinghies and the local farmer to discount the Dinsdale film[8]. (He had never seen the film himself, he told me in May 1985.)

Binns, unlike Burton or S. Campbell, had spent a significant amount of time actually watching at Loch Ness, as a member of the LNI. He is clear that "Burton was undoubtedly wrong in identifying the mystery object in Dinsdale's film as a local fishing boat" (Binns, 1983: 117). Those are dinghies with outboard motors. By contrast, Binns insists, *motor* boats can leave a wake with no central propeller-wash, just like the Dinsdale hump. As evidence he offers a photograph (Binns, 1983: 117, Plate 14) of a boat, whose wake bears no obvious resemblance to that of the hump in Dinsdale's film, heading towards the camera (whereas the hump was moving away), and on Loch Morar rather than Loch Ness.

Adrian Shine claims to discern a boat in a frame of the film captured from a commercial video; some other people fail to detect a boat in that frame (Hepple, 2001). Together with Richard Raynor and Richard Carter, Shine attempted to duplicate the Dinsdale film by photographing a boat using the same type of camera equipment as Dinsdale had used. The result looks just like the film of a clearly recognizable boat (G. Campbell, 1998, 1999; Hepple, 2001). One still from the Carter-Raynor-Shine attempt was shown in a television program (TDC, 1999); it looks nothing like Dinsdale's hump, not least in being motionless without a wake, and proves at best only that unfocused photographs of a distant object may be indistinct and hard to identify.

Thus, attempts to explain the Dinsdale hump as a boat have failed individually, have contradicted one another, and therefore have also failed collectively.

Sonar

Disbelievers have failed to offer an explanation for the fact that sonar searches in Loch Ness *frequently* (Mackal, 1976; LN&MP, 1983) obtain echoes that are stronger than those obtained from fish[9], echoes typically from *moving* targets. Of the 17 sonar watches up to 1972 listed by Mackal, Binns (1983: 147–53) mentions only six. S. Campbell (1986a: Chapter 6, Table 6) lists 11

claimed contacts between 1954 and 1972 and a further 7 up to 1982. Campbell's descriptions are detailed (pp. 75–96), but his dismissive summary (pp. 113–14) fails to address those details in any substantive way. Thus, one chart accepted by sonar experts as showing intrusion of large objects into the sound beam is countered by Campbell with "The marks on the chart… are entirely and necessarily explicable as signals from the boats involved and parts of the bottom of Urquhart Bay" (p. 90). Campbell himself is appropriately caustic about dogmatic hand-waving of that sort when indulged in by Nessie fans.

Critics have dismissed the sonar data as possibly reflections from the steep sides of the loch, artefacts owing to thermoclines or seiches, or large fish such as sturgeon, always without any specific evidentiary support. Echoes from apparently large and moving objects have been obtained from a great variety of types of sonar instruments: fixed as well as moving, side-scanning as well as fish-finding, scanning-and-tracking mounted on boats. It seems unlikely that all those modes would produce artefacts that similarly mimic large, moving objects.

Sonar with Simultaneous Photography

Disbelievers have offered no explanation for these photographs other than allegations of incompetent methodology (Steuart Campbell, cited in ABC video, 1987) or retouching (Anonymous, 1984). What exactly was supposedly incompetent about the methodology has not been explained; the AAS team included sonar engineer Martin Klein, photographic expert Charles Wyckoff, and Harold Edgerton, inventor of the strobe, recipient of the U.S. Medal of Freedom, and underwater photography advisor to Jacques Cousteau.

Binns (1983: 154 ff.) has no counter to the flipper photographs other than innuendo as to retouching or a possible hoax. S. Campbell (1986a: 113) simply chooses not to believe Gillespie or Wyckoff as to the allegation of retouching: "there is mystery regarding the provenance of U1/2 [the flipper photographs] and suspicion that an artist has been at work on them. One is not reassured by Wyckoff's explanation… Nevertheless there is a high probability that U1/2 show bottom debris".

The only significant point as to retouching is, do the original transparencies show the outline of a flipper? As Wyckoff (1984) and Gillespie (1980) have both testified, the flipper outline can be seen in the original negatives, a print of which has also been published independently (Sitwell, 1976); see also above under *Retouched?*

Eyewitnesses

Some people—and not only disbelievers—have questioned whether persisting reports of a long neck might not be based more on entrenched expectation of a prehistoric plesiosaur-like creature than on untutored raw observation. But the observations preceded the identification. Rupert Gould, who interviewed

eyewitnesses just as the Monster was making news, in November 1933, found that about one quarter of the 40-odd witnesses reported a neck (Gould, 1934: 42, 63–65, 67, 68–69, 72, 83–84, 90–92, 93, 95, 151). It was these accounts that led Gould to his identification of Nessie as a plesiosaur-like sea-serpent (Gould thought it a single specimen that had somehow become landlocked).

It is worth noting the near unanimity as to dark brown, gray, or black; as to hide versus scales; as to the head being little distinguished in shape or size from the neck; and also the frequent mention of a vertical submerging. It is not obvious what type of misperception would characteristically produce these particular, commonly reported details. Admittedly, information is lacking about what may have been already known about Nessies to the various people over the years who have reported sightings and what therefore they may have expected to see; but it does seem unlikely that many people besides Nessie enthusiast have been so familiar with the literature as to know that head and neck are almost indistinguishable, that the surface resembles hide rather than scales, that the color is dark brown or gray or black rather than green, and that Nessies sink vertically and not with a diving motion. After all, the popular media, and many postcards on sale, even around Loch Ness, offer a variety of such quite different descriptions as a serpentine many-humped creature with a head that is horse-like or dragon-like with pronounced ears, eyes, and snout.

The Surgeon's Photo

The Surgeon's photo (Figure 1), no matter that it has become Nessie's logo, is not among the strongest evidence that Nessies exist. The recent book by Martin and Boyd (1999) is devoted entirely to the allegation that this most famous photo was a hoax. But even if that is so, it does not lessen the case for Nessie any more than do any of the numerous undoubted hoaxes perpetrated over the years. Boyd himself continues to believe that Nessies exist (he had a remarkable sighting in 1979). I include a discussion here because it illustrates how disbelievers readily accept a story that discounts evidence for Nessies even when that story gapes with holes.

The account by Martin and Boyd has been comprehensively criticized by Shuker (1995:87) and by Smith (1995, 1999), and it was not accepted even by Steuart Campbell (1995), who denies that Nessies exist but has a different explanation for the Surgeon's photo[10]. The chief evidence adduced by Martin and Boyd comprises what they heard from 89-year-old Christian Spurling, who claimed to have been one of the hoaxers. Spurling died before his story was published, so those who found it implausible were not able to question him on any of the unconvincing points, which include:

1. Spurling failed to mention the second photo from the same occasion, which had been developed and printed at the same local shop in Inverness as the subsequently famous one (Whyte, 1957: 7, frontispiece).
2. Spurling described a roundabout, difficult, even farfetched method: using a 35-mm camera and then re-photographing onto a plate, involving

negative to positive to negative. Why not use the plate camera in the first place?

3. One of the alleged co-conspirators, Ian Wetherell, told a different story, namely that the 35-mm film had been sent off for developing (Martin and Boyd, 1999: 14). Yet it is known that Wilson had given plates for developing to an Inverness pharmacy (Whyte, 1957: 7).
4. Ian Wetherell claimed that the toy submarine used to support the faked head-and-neck had been put in motion to make "a proper little V" wake in the water. Figure 1 shows no such wake.
5. One of the people to whom Wilson had allegedly confessed the hoax said Wilson related that his friend "had taken a photograph of the loch and then at home had apparently superimposed a model of a monster on the plate" (Martin and Boyd, 1999: 71), yet another different procedure than that described by Spurling.
6. The motive for the hoax was said to be retribution by Marmaduke Wetherell against the newspaper, the *Daily Mail,* that had dispensed with his services. The *Daily Mail* had fired Wetherell after he had discovered a spoor on the shore that turned out to have been faked with a preserved hippopotamus foot. Martin and Boyd (1999: 27) now reveal that Wetherell had himself faked that spoor. In that case, what possible reason could he have had to feel that the *Daily Mail* should not have dispensed with his services after the hoaxing of the spoor had come to light?
7. In any case, if the hoax were designed to embarrass the *Daily Mail* by inducing it to publish a photograph that could then be unmasked as a fake, why was the hoax not revealed as soon as the *Daily Mail* had been entrapped into publishing the photo?

The 1975 Underwater Photographs

In 1975, the AAS obtained more underwater photos (Figure 4), but without simultaneous sonar (Rines et al., 1976). One of the photos appears to show a head (Figure 4a and b) and another one the silhouette of a body with a long neck (Figure 4c). The "gargoyle" head looks reptilian, with rather thick lips and some teeth in the lower jaw, looking outwards from the plane of the picture towards the right; there appear to be two short projections on top of the head. The "body-neck" photo resembles the front of an animal with two stumpy appendages hanging down and a long neck curving away.

Critics have suggested that the gargoyle head is a pile of rocks (Bauer, 1987b) or a tree stump (Dash, 1988) and that the body-neck is the reflection of light from the photographic strobe by particles in the water, with a foreground log whose shadow makes the reflected light take the shape of an animal. Those are not implausible interpretations in themselves. However, in judging overall plausibility, one should also consider what the probability is that underwater photographs taken at Loch Ness would resemble eyewitness reports of ani-

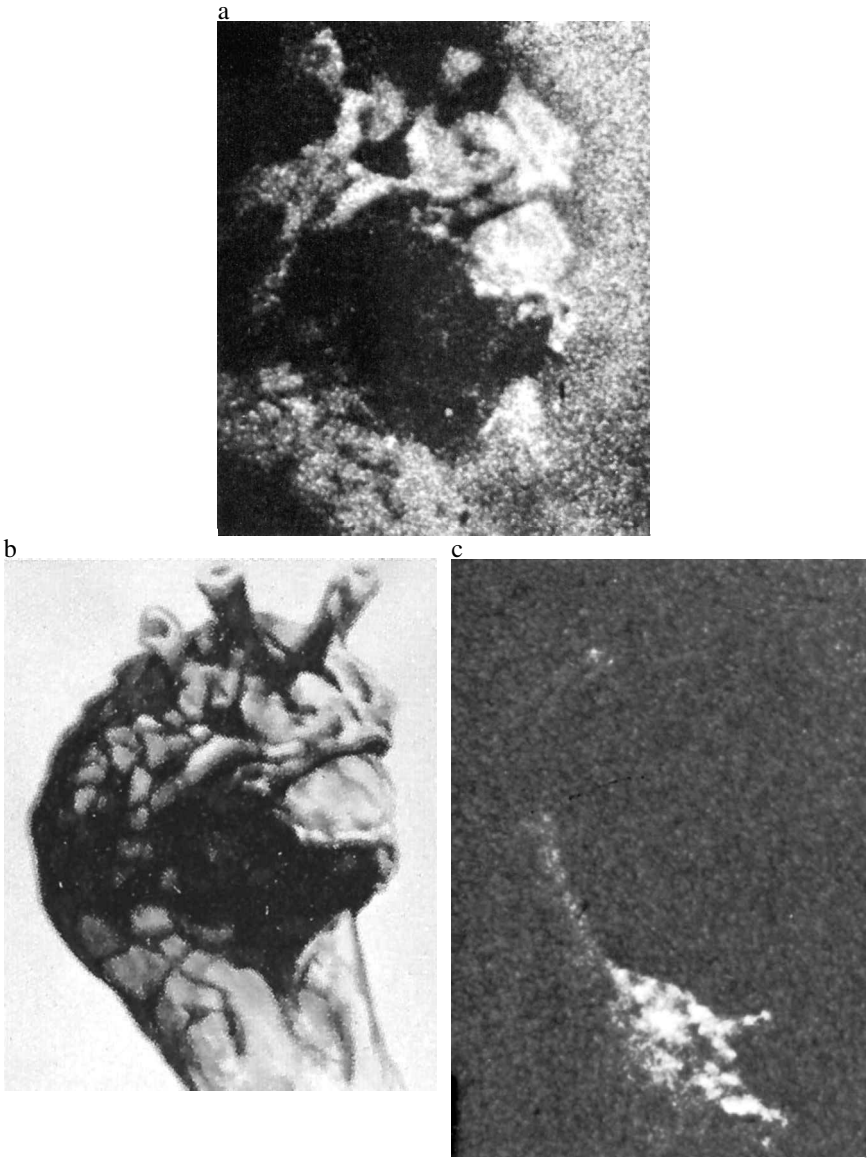

Fig. 4. Reproduced by permission from Rines et al. (1976). a) The "gargoyle head" photo. b) Sir Peter Scott's interpretation of the "gargoyle". c) The "body-neck" photo.

mals. Of the 6 photographs obtained on several occasions, hours apart, in 1975, one looks much like a sandy bottom strewn with rocks (Rines et al., 1976: 34, B); two (Rines et al., 1976: 34, A & F) have no obvious interpretation; one (Rines et al., 1976: 34, D) looks rather like a crocodilian neck and head; the remaining two are the gargoyle and body-neck shown above.

If there are no Nessies, what are the chances that 3 out of 6 underwater photographs, obtained on separate occasions, would capture logs or debris that look like various parts of a Nessie?

What Could Nessies Be?

If the descriptions of Nessies provided by photos and eyewitnesses could be interpreted as some species of animal known from anywhere else in the world, there would be no great fuss about it. If sharks, say, or dolphins, or some small whales had adapted to fresh water, that would be quite interesting to biologists but no reason for world-wide media or public interest. The trouble is, Nessies look like nothing now known to be alive *anywhere*. Perhaps even worse, they look rather dinosaur-like. The real animals that they resemble most closely are plesiosaurs, marine creatures that once thrived in the oceans all over the globe but that are believed to have been extinct for tens of millions of years. Moreover, plesiosaurs are believed to have been fish-hunting predators that ranged close to the surface, not several hundred feet deep, as Nessies seem to like to be.

There are excellent reasons why Nessies should not be any of the sorts of creatures that various people have suggested (Mackal, 1976): a huge invertebrate (none approaching the size of Nessies has ever been known); an amphibian (again, none approaching the size of Nessies has ever been known); a reptile (the water is too cold); a mammal (would need to breathe and would therefore be often seen at the surface—as also would reptiles). So frustratingly puzzling is this mystery of possible identity that a few people have made extraordinarily far-fetched proposals, for instance, that Nessies are some sort of *psychic* rather than physical phenomenon (Holiday, 1986). There is, however, a less implausible possibility: a yet-to-be-discovered species that is deep-dwelling in the oceans as well as in some deep lakes.

That the depths of the oceans remain largely unexplored is a simple matter of fact. The coelacanth is illustrative: the first one was recognized in 1938, but it was not until 1952 that a second specimen was obtained even though substantial rewards had been offered. Nowadays looking at coelacanths has become almost routine, via television cameras hundreds of feet below the surface in the little area near the Comores that was thought to be their only habitat. But then again, more recently a new species of coelacanth has been discovered whose home seems to be near Indonesia.

An even more striking illustration of humankind's ignorance of the depths is the megamouth shark, caught by chance about 25 years ago and representing, moreover, a family completely absent from the known fossil record. The recent television series *The Blue Planet* (2001) features a number of other previously unknown and accordingly bizarre, albeit smaller, deep-ocean dwellers.

The case of the giant squid (Heuvelmans, 1968) is also instructive or suggestive. Once regarded as mythical, it became accepted when sizable portions of various large ones were washed ashore; and marine biologists have for some

years now attempted, so far unsuccessfully, to capture a complete and fully grown specimen of this deep-dwelling species (Ellis, 1998; TDC, 2000).

So it is surely not too farfetched to contemplate the possibility of another deep-living marine species that has not yet been thoroughly identified and is known so far only through its rare appearances near the surface, in the oceans as sea-serpents, in Loch Ness as Nessies, in Loch Morar as Morags, and perhaps in a few other deep lakes as well. Nessies and Morags will have become landlocked (as Constance Whyte first suggested) as the land rose following the last Ice Age, perhaps 10,000 to 15,000 years ago. Both Loch Ness and Loch Morar are of the order of twice as deep as the North Sea. When they were part of the ocean for a time as the Ice Age was coming to an end, these will have been deep as well as large sea-fjords in which the Nessies will have foraged and eventually become trapped.

An obvious objection to this thesis is that—apart from sonar—all the data about Nessies have been gathered from surface or near-surface appearances. Why would habitually deep-dwelling creatures ever come up?

These objections can be answered. However, the following particular answers are intended only to show that plausible answers are available; it is not being claimed that these are necessarily correct. Air-breathing animals, even large ones, can come up quite unobtrusively to breathe; some species of plesiosaurs had nostrils at the top of the skull. Increasing water traffic might well drive the creatures to be even more reclusive and selective in their journeys to the surface. Fish-eating creatures might well come close to the surface for particularly enticing food. The AAS underwater photography was based on the premise that channels leading up to salmon rivers were likely places to find Nessies at least some of the time, and the successful photos might seem to bear that out. Less success in the last quarter century might stem from the notorious decline in salmon runs, and perhaps also from the fact that Urquhart Bay, where the AAS photos were obtained, has experienced considerable silting in recent years as well as the construction of a marina not far from the observation points where the photos had been obtained.

Sightings have always been rare, except perhaps in the early 1930s, when a large number of people were watching intently; trees along the loch had been removed during road-building, and noisy blasting as well as ditching of much rubbish into the water might have aroused the creatures to come up more frequently and obviously. Most sightings are brief, though on rare occasions they may last for tens of minutes. Such surfacings might bespeak illness, or perhaps something associated with reproduction.

At any rate, there is nothing decisive about claims that deep-dwelling creatures are inconsistent with occasional surface appearances. Giant squid remain to be captured mature and whole, but significant bits are washed ashore occasionally; and their existence was known at first only from incredible stories of ships being attacked by long-armed monsters. Coelacanths live at depths of hundreds of feet, yet the first and second ones delivered to science were caught by commercial fishermen.

If the deep-dwelling hypothesis is correct, then sonar would seem to be the prime technique to be used in searching for these creatures, but the quest might usefully be extended to deep sea-fjords. It is intriguing that on several occasions over the years, Scandinavian navy ships have reported sonar contact with apparent foreign submarines that subsequently, however, always disappeared before they could be identified[11].

It would be natural for deep dwellers to come to rely on senses other than sight, possibly on sound or echo location (sonar). It is intriguing that on one occasion, the AAS did detect an apparent sound emission from a strong underwater target in Loch Ness (Rines & Curtis, 1979). If Nessies employ sonar, then they might best be sought with sound of frequencies that they would be least likely to detect. One should then begin by deploying hydrophones in the deepest portions of Loch Ness. Recorded sounds should be examined to identify possibly favored frequencies. Subsequent sonar searches would use sound waves of other frequencies.

Notes

[1] The JARIC examination had been carried out at the behest of a Member of Parliament, David James, who had organized a decade-long systematic surveillance of Loch Ness during the 1960s. (The organization was first called the Loch Ness Phenomena Investigation Bureau, later shortened to Loch Ness Investigation or LNI.)

[2] Inevitably this was some hours later. Lighting conditions were different since the sun was now higher, and the water appears calmer. Nevertheless, the dimensions and speed of the boat afford useful controls.

[3] By the Jet Propulsion Laboratory (Martin, 1976) and for several television documentaries (History, 1998; NOVA, 1998; TDC, 1993).

[4] Loch Ness is joined to the sea, at the north to the Moray Firth and at the south through a series of other lochs to the sea-loch Linnhe and the Sea of the Hebrides. The rivers forming these connections are so shallow, and the canals (together, the Caledonian Canal) so narrow and interspersed with locks, that no large object could go in or out of Loch Ness without being observed.

[5] If an object is stationary and a narrow beam of sound can be scanned across it, a shape may be discernible. That is how the wreck of the Titanic was recognized and how a submerged airplane was discovered in Loch Ness (Klein & Finkelstein, 1976) that was later recovered and is now exhibited in a museum (Harris, n.d.).

[6] I am indebted to Bob Rines for pointing this out (phone conversation of 2 December 2001).

[7] Witchell's book has been brought up to date several times, most recently in 1989.

[8] As well as relying on Burton, Campbell (1986b) tries to make a hump-as-boat identification plausible by speculating about how JARIC might have mis-

calculated. In response, Dinsdale (1990) pointed out that Campbell erred in several respects:

- Campbell's guess, that the map Dinsdale supplied JARIC was the sketch from his book, was wrong: it was part of an Ordnance Survey map of scale 1 inch to 1 mile. Campbell based some of his calculations on that sketch, and all of them are therefore in error.
- Campbell was wrong about the elevation of Observation Points on the map, the site of filming with respect to that, and subsequent calculations.
- Campbell was wrong in his speculative reconstruction of the details of Dinsdale's filming.
- Campbell stated that the type of film Dinsdale used was unknown. It was Kodak Plus X, ASA 50, as Campbell might have discovered had he asked.

[9] For example, one was characterized as "larger than a shark but smaller than a whale" (A&E, 1994).

[10] Commenting on an earlier draft of this article, Campbell wrote that he now accepts the explanation by Martin and Boyd as the most likely one. I retain reference to his earlier demurrer to illustrate that Martin and Boyd's account is not immediately or obviously convincing even to as confirmed yet independently thinking a disbeliever as Campbell.

[11] "Swedish navy helicopters have again dropped depth charges off northern Sweden and divers have searched the seabed for evidence of intruding submarines… It was the third time… since a hunt began on July 1 for suspected foreign submarines" (*Scotsman,* 17 July 1987). "Every year Sweden launches a hunt for submarines… which it says lurk in its neutral waters. The hunts have been fruitless" (*Aberdeen Press & Journal,* 2 September 1988).

Acknowledgments

The *Journal of Scientific Exploration* seemed the best place to publish this article. Since the author is also Editor of the *Journal,* no truly disinterested mode of having the piece refereed seemed available. Consequently it is published not as a Research Article but as an Essay. In lieu of formal refereeing, I sent the MS. for comment to a number of interested people, including non-believers and disbelievers as well as fellow believers. I am most grateful for all the responses, as a result of which the essay is greatly improved from its initial drafts, in particular concerning the significance of eyewitness testimony.

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